REMARKS

Applicants wish to thank Examiner Rada for considering this matter with their agent's assistant, Kelly Ray, on 6 November 2002, during which it was determined that the preferred method for compliance in this matter was through the submission of replacement pages since a number of changes were made throughout the text of the specification. The replacement pages are included with the instant response. If any further materials or clarification is required, the Examiner is urged to contact Applicants' agent at the telephone number indicated below. Your consideration of this matter is appreciated.

Respectfully submitted,

Perry J. Hoffman
Reg. No. 37,150

Docket No.: 090455-9307
Michael Best & Friedrich LLC
401 N. Michigan Ave., Suite 1900
Chicago, IL 60611
(312) 222.0800
(312) 222.6636 (direct number)

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the first storage unit, sound patterns stored in the second storage unit, and expression patterns stored in the third storage unit. The selection of a combination of the posture motion pattern, sound pattern, and expression pattern stored in the memory facilitates selection of a combination of the posture motion pattern, sound pattern, and expression pattern. The expression pattern includes a motion pattern for changing at least the size or the shape of the eyes. Thus, produced is an expression according to the changes in the character at such time. The electronic toy is thus capable of controlling motions arbitrarily in accordance with external inputs with a head housing a drive motor and a transmission mechanism for transmitting rotational driving force to the drive motor, a display for displaying the shape of the eyes and provided ~~to~~ <u>from</u> the front of the head, first detection means provided on the top of the head and for detecting the pressing thereof, second detection means for detecting sound, third detection means for detecting the peripheral brightness, a body housing a cam mechanism ~~for transmitting~~ <u>, which is driven by</u> rotational driving force ~~to~~ <u>from</u> said drive motor via the transmission mechanism, legs driven by said cam mechanism, a lower jaw driven by said transmission mechanism, ears driven by said transmission mechanism, storage means for storing the respective motion patterns of the legs, lower jaw, and ears, and a controller for selecting an arbitrary motion pattern among the plurality of motion patterns stored in the storage means in accordance with the timing of detection signals output from the first to third detection means, and controlling the drive motor and the display pattern of the display in accordance with the selected motion pattern. Arbitrary motion patterns are then selected among a plurality of motion patterns stored in the storage means according to the timing of the detection signals output from the first through third detection means, and as the drive motor and the display pattern of the display are controlled according to the selected motion pattern.

The electronic toy arbitrarily controls motions in accordance with external inputs by setting the initial mode for a period after the power is turned on until a prescribed time elapses, detecting external inputs while the initial mode is initialized such that the individual differences of gender and the like may be determined pursuant to the number of times the user contacts the toy while the initialization mode is being set after the batteries are foremost installed. This enables the production as though the electronic toy has a gender and character of an animal as individual differences will appear with respect to the expression,

sound, and motion in correspondence with the contact of the user after initialization. The individual difference setting means sets individual differences pursuant to whether the count value of the counter is an add or even number. Accordingly, individual differences are set pursuant to whether the count value of the number of inputs detected during the setting of the initialization mode is an odd or even number. This further enables the production as though the electronic toy has a gender and character of an animal as individual differences will appear with respect to the expression, sound, and motion in correspondence with the contact of the user after initialization. The electronic toy may also be provided with gender and like characteristics of an animal as individual differences appear with respect to the expression, sound, and motion in correspondence with the contact of the user after initialization.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiments of the present invention are now explained with reference to the drawings.

FIG. 1 is a front view of the electronic toy according to an embodiment of the present invention;

FIG. 2 is a side view of the electronic toy shown in FIG. 1;

FIG. 3 is a plan view of the electronic toy shown in FIG. 1;

FIG. 4 is a rear view of the electronic toy shown in FIG. 1;

FIG. 5 is a bottom view of the electronic toy shown in FIG. 1;

FIG. 6 is a perspective view of the electronic toy shown in FIG. 1;

FIG. 7 is a side view of the electronic toy showing the rotational direction and rotational angle of the legs;

FIG. 8 is a side view showing the motional state when the electronic toy is in the sleeping posture A;

FIG. 9 is a side view of the motional state when the electronic toy is in the standing posture B;

FIG. 10 is a side view of the motional state when the electronic toy is in the leaning-forward posture C;

FIG. 11 is a front-vertical cross section showing the internal structure of the electronic toy;

FIG. 12 is a side-vertical cross section showing the internal structure of the electronic toy;

FIG. 13 is a plan-vertical cross section showing the internal structure of the electronic toy;

FIG. 14 is a front view separately showing the red acryl plates built in the display;

FIG. 15 is a diagram showing the combinations of the display patterns to be illuminated and displayed on the display;

FIG. 16 is a block diagram showing the structure of the control system of the electronic toy;

FIG. 17 is a block diagram showing the structure of the controller;

FIG. 17A illustrates a feeding device in the form of a bone containing magnetic material;

FIG. 18 is a flowchart for explaining the control processing executed by the CPU 80 of the controller;

FIG. 19 is a graph showing the changes in the pet biorhythm and communication biorhythm with control method of motions and expressions in accordance with the motional input from the respective sensors during the happy mode;

FIG. 20 is a flowchart for explaining the initialization processing; and

FIG. 21 is a flowchart for explaining a modified example of the initialization processing;

FIG. 22 shows male and female gender data associated with eye patterns A and B shown in FIGS. 23 and 24 respectively, with associated voice and song gender characteristics;

FIG. 25 is a front view of the electronic toy according to the second embodiment of the present invention;

FIG. 26 is a side view of the electronic toy shown in FIG. 25;

FIG. 27 is a plan view of the electronic toy shown in FIG. 25;

FIG. 28 is a rear view of the electronic toy shown in FIG. 25;

FIG. 29 is a bottom view of the electronic toy shown in FIG. 25;

FIG. 30 is a perspective view of the electronic toy shown in FIG. 25;

FIG. 31 is a diagram showing the combinations of motion types of the electronic toy 90 and the motion positions of the legs 16-19; (A) is a diagram showing the

combinations of the motion types and the motion positions of the legs 16-19; and (B) is a diagram respectively showing the rotation angles of the legs 16-19;

FIG. 32 is a side view for explaining a motion of "stand" of the electronic toy 90;

FIG. 33 is a side view for explaining a motion of "sit" of the electronic toy 90;

FIG. 34 is a side view for explaining a motion of "hand" of the electronic toy 90;

FIG. 35 is a side view for explaining a motion of "lie down" of the electronic toy 90;

FIG. 36 is a diagram showing an example of the display patterns on the display 20; (A) is a diagram showing smiling eyes; (B) is a diagram showing ? eyes; (C) is a diagram showing heart-shaped eyes; (D) is a diagram showing melancholy eyes; and (E) is a diagram showing round eyes;

FIG. 37 is a diagram for explaining a sound registration; (A) is a diagram showing an example of registered words to be used in sound registration; (B) is a flowchart for explaining the steps of sound registration; (C) is a flowchart for explaining an unsuccessful example of sound registration; and (D) is a flowchart for explaining a successful example of sound registration;

FIG. 38 is a diagram for explaining an example of conditions for character formation; (A) is a diagram showing the characteristics of the characters; (B) is a diagram showing an example of the character formation parameter MAP; and (C) is a diagram showing an example of conditions for character changing;

FIG. 39 is a diagram for explaining an example of character registration motions; (A) is a diagram showing an example of an incorrect motion; and (B) is a diagram showing an example of a correct motion;

FIG. 40 is a graph showing the characters set in accordance with the variation (increase) of the number of points in a faithful dog parameter I and a performing dog parameter II which are registered in the character formation parameter MAP 102; (A) is a graph showing a faithful dog setting mode; (B) is a graph showing a performing dog setting mode; and (C) and (D) are graphs showing cur setting modes;

FIG. 41 is a diagram explaining the mood parameters; (A) indicates the level of the mood parameter; (B) indicates the state of the respective level; (C) indicates positive

conditions to the mood parameter; and (D) indicates negative conditions to the mood parameter;

FIG. 42 is a diagram explaining the fullness parameters; (A) indicates the level of a fullness parameter; (B) indicates the state of the respective level; and (C) indicates positive conditions to the fullness parameter, and (D) indicates negative conditions to the fullness parameter;

FIG. 43 is a graph showing an example of the mood parameter changes;

FIG. 44 is a graph showing an example of the changing values of the mood parameter in accordance with the fullness parameter value P_B;

FIG. 45 is a flowchart of the main processing executed by the controller 62 of the electronic toy 90; and

FIG. 46 is a flowchart of the main processing executed following the processing of FIG. 45.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIGS. 1 through 6, the electronic toy 10 is a dog-shaped toy having, in summary, a head 12, body 14, and legs 16-19. Although the electronic toy 10 of this embodiment is structured such that the four legs 16-19 are provided to both sides of the body 14, it does not walk. That is, the electronic toy 10 is structured to change its posture by the rotational motion of the legs 16-19 by rotating such legs 16-19 at a prescribed angle in accordance with the changes in the feeling as described later.

The four legs 16-19 are respectively formed of circular axes 16a-19a rotatably supported at both sides of the body 14, shanks 16b-19b extending in the radial direction from the axes 16a-19a, and toes 16c-19c provided at the tip of the shanks 16b-19b.

Moreover, the legs 16-19, axes 16a-19a, shanks 16b-19b, and toes 16c-19c are formed integrally, and joints ~~similar to~~ different from those of actual ~~does~~ dogs are not provided to the legs 16-19. Semispherical caps 16d-19d are provided to the side of the axes 16a-19a, and these caps 16d-19d may be colored an arbitrary color.

A display 20 for displaying the expression of the eyes is provided to the front of the head 12. Although this display 20 ordinarily displays oval eyes pursuant to the illumination of light emitting diodes (LED), a plurality of LEDs may be selectively illuminated as explained later in order to change the display pattern of the eyes for expressing the feeling at such time.

A sound sensor 24 (sound detection means) structured of a microphone for detecting peripheral sounds is built in the tip face of the nose 22 protruding frontward from the ~~from~~ front of the head 12. A light sensor 25 for detecting the peripheral brightness is stored in the upper corner of the nose 22. The light sensor of the present embodiment, for example, is formed of CdS cells (cadmium sulfide cells) and outputs detection signals in accordance with the brightness of the incoming light.

A speaker 26 for producing barking sounds or playing melodies is provided to the upper face of the head 12. This speaker 26 is mounted slidably in the upward/downward directions as described later and, for example, when the head 12 is pushed, the speaker 26 is moved downward so as to detect that the toy has been stroked.

On both sides of the head 12, provided are ears 28 formed of semi-transparent material colored an arbitrary color different than that of the head 12. The upper part of the ears 28 are connected rotatably to the side of the head 12 and, as explained later, rotates upward or downward in accordance with the changes in the feeling at such time.

A lower jaw 30 at the lower side of the nose 22 is provided rotatably to be in an opened position or closed position and operates with the mouth 31 in an open state or closed state in accordance with the changes in the feeling at such time.

A tail 32 is ~~reciprocally~~ provided to the rear of the body 14~~, and the tail 32 moves~~ so as to move upward or downward in accordance with the changes in the feeling at such time.

The motion patterns of the electronic toy 10 structured as above are explained below. As shown in FIG. 7, the front legs 16 and 17 among the legs 16-19 are provided such that they are capable of being positioned in motion position A rotated 60 degrees in the forward direction (a direction) from standstill position B, and in motion position C rotated 30 degrees in the backward direction (b direction) from standstill position B. Moreover, the hind legs 18 and 19 are provided such that they are capable of being positioned in motion position A rotated 90 degrees in the forward direction (a direction) from standstill position B, and in motion position C rotated 45 degrees in the backward direction from standstill position B.

FIG. 8 is a side view showing the motional state when the electronic toy 10 is in the sleeping posture A. As shown in FIG. 8, when the electronic toy 10 is in the sleeping posture A, the respective legs 16-19 are rotated to motion position A. Thus, the respective

legs 16-19 are extending forward along both sides of the body 14, the bottom of the body 14 is near the floor 34, and the electronic toy 10 is therefore in posture A. Therefore, the electronic toy 10 may express with its entire body the feeling of, for example, sleepiness or gloominess, by taking posture A described above.

FIG. 9 is a side view of the motional state when the electronic toy 10 is in standing position B. As shown in FIG. 9, when the electronic toy 10 is in the standing posture B, the respective legs 16-19 are rotated to motion position B. Thus, the respective legs 16-19 are rotated to a position (standstill position B) such that they extend downward from both sides of the body 14, the bottom of the body 14 is far from the floor 34, and the electronic toy 10 is therefore posture B. Further, during posture B, the whole surface of the bottom of the respective legs 16-19 (bottom of feet) is closely contacting the floor 34 ~~in close adhesion~~. Therefore, the electronic toy 10, for example, when it is not doing anything, maintains the aforementioned standing posture B in ordinary situations.

FIG. 10 is a side view of the motional state when the electronic toy 10 is in the leaning-forward posture C. As shown in FIG. 10, when the electronic toy is in the leaning-forward posture C, the respective legs 16-19 are at motion position C by being rotated in the b direction with respect to posture B. Thus, the respective legs 16-19 become a posture similar to a tiptoe by standing on the tip of the toes 16c-19c, the heels of the respective legs 16-19 will rise from the floor 34, and the electronic toy is therefore in posture ~~e~~ C. During posture C, the lower jaw 30 is rotated in the lower direction ~~©~~ c direction) in order to open the mouth, and the tail 32 is rotated in the upward direction (d direction). Moreover, ~~although not shown in FIG. 1,~~ the ears 28 shown in FIG. 1 will rotate in the upward direction (e direction). Therefore, the electronic toy 10 may express with its entire body the feeling of, for example, happiness or pleasure by taking posture C described above.

With the electronic toy of this embodiment, the motion patterns of the three types of postures A-C described in aforementioned FIGS. 8-10 are the basic motions. The internal structure of the electronic toy 10 is now described.

FIG. 11 is a front-vertical cross section showing the internal structure of the electronic toy 10. FIG. 12 is a side-vertical cross section showing the internal structure of the electronic toy 10. FIG. 13 is a plan-vertical cross section showing the internal structure of the electronic toy 10.

As shown in FIGS. 11 through 13, the electronic toy 10 internally comprises in the head 12 a motor 36 and a transmission mechanism (transmission means) 38 for transmitting the rotational driving force of the motor 36 to the legs 16-19, ears 28, lower jaw 30, and tail 32. The aforementioned legs 16-19, ears 28, lower jaw 30, and tail 32 are respectively driven by one motor 36, and are selectively transmitted the rotational driving force of the motor 36 by the transmission mechanism 38 in accordance with the aforementioned postures A, B, and C.

The motor 36 and transmission mechanism 38 are supported by the bracket 41 provided inside the head 12 and body 14. Therefore, the motor 36 and transmission mechanism 38 are of a compact structure, and are made to correspond to the miniaturization of the electronic toy 10.

Further, the transmission mechanism 38 comprises: a drive gear 40 mounted on the drive axis 36a of the motor 36; a first transmission gear 42 for engaging with the drive gear 40; a second transmission gear 44 for engaging with the first transmission gear 42; a third transmission gear 46 for engaging with the second transmission gear 44; a fourth transmission gear 47 for engaging with the third transmission gear 46; a first cam gear 48 co-axially provided with the fourth transmission gear 47; a first shaft 50 for supporting the first cam gear 48; a fifth transmission gear 52 for supporting the first shaft 50; and a second cam gear 54 for engaging with the fifth transmission gear 52.

Transmission gears 42, 44, 46 are respectively structured of large-diameter gears 42a, 44a, 46a and small-diameter gears 42b, 44b, 46b formed integrally, and decelerate the rotation from the motor 36 at a prescribed deceleration ratio. Moreover, the bracket 41 supports the axes 42c, 44c, 46c to which the respective transmission gears 42, 44, 46 are engaged.

The first cam gear 48 is a driving means for driving the front legs 16, 17, and is formed to rotate such legs 16, 17 to the aforementioned rotational positions A, B, C in accordance with the rotational directions and rotational amounts of the drive axis 36a of the motor 36. The third and fourth cam gears 54, 55 are driving means for driving the hind legs 18, 19, and are formed to rotate such legs 18, 19 to the aforementioned rotational positions A, B, C in accordance with the rotational directions and rotational amounts of the drive axis 36a of the motor 36.

The second cam gear 54 drives the tail 32, and is also connected to the transmission path 56 for driving the ears 28 and lower jaw 30. This transmission path 56 is formed, for example, from a wire and pulley etc. as shown with the one-point chain lines and rotates the ears 28, lower jaw 30 and tail 32 in the e, c, and d directions during the process of rotating the legs 18, 19 from motion position B to motion position C pursuant to the rotational angle of the second cam gear 54.

A battery housing 60 for housing batteries 58 as the power source is internally provided to the head 12. A substrate 64 having a controller 62 mounted thereon is housed inside the nose 22. A speaker 26 is provided slidably in the upward/downward directions, and comprises thereunder a push-type detection switch (contact detection switch) 59 for detecting that the speaker 26 has been pushed and moved downward.

The detection switch 59 is for detecting the lowering of the speaker 26 by the user stroking or knocking on the head 12, and is capable of making such detection while being insensible to the contact made by the user.

The motor 36 and batters 58, which are comparatively heavy among the aforementioned structural components, are arranged at a position near the centroid of the electronic toy 10; that is, at the approximate center of the head 12. The electronic toy 10 is therefore able to maintain the respective postures with steadiness.

Next, the structure of the display 20 for displaying the expression of the eyes is explained. A black smoke plate 68 is mounted on the front display 20, and four red acryl plates 71-74 of end face-illumination are layered on the inside of the smoke plate 68. Light emitting diodes (LEDs) 75-79 are arranged at the upper and lower parts of the respective red acryl plates 71-74. Other than the end face-illumination type described above, other forms of display devices (e.g., liquid crystal displays with back lights, etc.) may be used as the display 20.

FIGS. 14(A)-14(D) are front views separately showing the red acryl plates built in the display 20. As shown in FIG. 14(A), the red acryl plate 71 comprises illuminators 71a, 71b arranged in an oval shape with the bottom parts removed. These illuminators 71a, 71b have small holes provided in prescribed intervals, and red light is emitted from the inner walls of the respective small holes when light from the LEDs 75, 76 enters the entrance 71c provided on the end face. Therefore, the upper parts of the left and right eyes will illuminate in an upside down U-shape pursuant to the illumination of the illuminators 71a, 71b.

A screen 71e for blocking the light is provided between the illuminators 71a and 71b. Thus, when light is emitted from only one of the LEDs 75, 76, one of the illuminators 71a, 71b will illuminate and produce the effect of a wink.

As shown in FIG. 14(B), the red acryl plate 72 comprises illuminators 72a, 72b arranged in a heart shape. These illuminators 72a, 72b have small holes provided in a heart shape in prescribed intervals, and red light is emitted from the inner walls of the respective small holes when light from the LED 77 enters the entrance 72c provided on the end face. Thus, the left and right eyes will illuminate in a heart shape by the illuminators 72a, 72b illuminating.

As shown in FIG. 14(C), the red acryl plate 73 comprises illuminators 73a, 73b arranged in a small semicircular shape formed continuously at the lower part of the illuminators 71a, 71b shown in FIG. 14(A). These illuminators 73a, 73b have small holes provided in a semicircular shape in prescribed intervals, and red light is emitted from the inner walls of the respective small holes when light from the LED 78 enters the entrance 73c provided to the end face. Thus, the left and right eyes will illuminate as small, angry eyes by the illuminators 73a, 73b illuminating.

As shown in FIG. 14(D), the red acryl plate 74 comprises illuminators 74a, 74b arranged radially in small points formed continuously at the lower part of the illuminators 71a, 71b shown in FIG. 14(A). Regarding these illuminators 74a, 74b, red light is emitted from the inner walls of the respective small holes when light from the LED 79 enters the entrance 74c provided at the end face. Thus, the left and right eyes will illuminate as crying eyes by the illuminators 73a, 73b illuminating.

The arrangement of the aforementioned LEDs 75-79 is such that the LEDs are distributed at the upper or lower parts of the red acryl plates 71-74 so that light will not enter into other adjacent red acryl plates, and are covered with a partition wall (not shown) for preventing the light from leaking into its periphery. Thereby, the respective display patterns will not interfere with each other even when the red acryl plates 71-74 are superposed, and it is further possible to place such plates 71-74 in a small space inside the head 12.

FIG. 15 is a diagram showing the combinations of the display patterns to be illuminated and displayed on the display 20. As shown in FIG. 15, the display 20, for example, is capable of selectively displaying nine (9) types of display patterns ①-⑨. In display pattern ①, the LED 77 is lit and illuminators 72a, 72b arranged in a heart shape are

illuminated. In display pattern ②, the LED 76 is lit and the illuminator 71b of the upper right eye is illuminated. In display pattern ③, the LED 78 is lit and illuminators 73a, 73b of the left and right angry eyes are illuminated. In display pattern ④, LEDs 75, 78 are lit and the illuminator 71a of the left eye is illuminated, and illuminator 73a, 73b of the left and right angry eyes are also illuminated to display the right-eyed wink. In display pattern ⑤, LEDs 75, 76, 79 are lit and illuminators 71a, 71b of both eyes are illuminated, and illuminators 74a, 74b representing tears in both eyes are illuminated to display crying eyes. In display pattern ⑥, LEDs 75, 76, 78 are lit and illuminators 71a, 71b of the left and right upper round eyes are illuminated, and illuminators 73a, 73b of the left and right lower round eyes are illuminated to display the overall oval-shaped round eyes. In display pattern ⑦, the LED 75 is lit and the illuminator 71a of the left upper round eye is illuminated. In display pattern ⑧, LEDs 76, 78 are lit and the illuminator 71b of the right eye is illuminated, and illuminators 73a, 73b of the left and right angry eyes are also illuminated to display the left-eyed wink. In display pattern ⑨, the respective LEDs 75-79 are turned off so that no illumination is displayed on the display 20.

At the display 20, lighting control of the respective LEDs 75-79 is conducted pursuant to control signals from the controller 62. This produces changes in the emotions at such time by representing the expressions with any one of the aforementioned nine (9) types of display patterns ①-⑨.

The structure of the control system of the aforementioned electronic toy 10 is described below.

FIG. 16 is a block diagram showing the structure of the control system of the electronic toy 10. As shown in FIG. 16, the controller 62 is connected to the display 20, sound sensor 24, light sensor 25, speaker 26, motor 36, battery 58, detection switch 59, and, as described later, counts the detection signals from the sound sensor 24, light sensor 25, detection switch 59. The controller 62 thereby drives and controls the display 20, speaker 26, and motor 36 by extracting control data from the relationship of the count value and elapsed time.

Various artificial intelligence (AI) functions and sensor training are provided in which training between the random and sequential behavior modifications of the electronic toy allows the child to provide reinforcement of desirable activities and responses. In connection with the AI functions, appropriate responses are performed for particular activities

or conditions, e.g., bored, hungry, sick, sleep. Such predefined conditions have programmed responses which are undertaken by the electronic toy at appropriate times in its operative states. The AI and sensory training functions achieve behavior modification for the interactive toy, thus allowing the child to provide reinforcement of desirable activities and responses. The AI functions are used for the appropriate responses to particular activities or predefined conditions undertaken by the interactive toy at appropriate times in its operative states. Additionally, as discussed, the interactive toy maintains its age in a non-volatile memory, which is used to increment the age where appropriate. Additionally, a co-processor facilitates infrared (IR) communications allowing for communications between electronic toys as discussed herein. Other criteria based on the electronic toy's life as stored in memory may affect the ability to play games. For instance, if the electronic toy is indicated as being sick, either by having received a signal from another electronic toy to enter the sick condition, then no game would be played.

FIG. 17 is a block diagram showing the structure of the controller 62. As shown in FIG. 17, the controller 62 comprises a CPU 80 as the central processing unit, ROM 82 (storage means; first-third storage units), RAM 84, and timer 86. Stored in the ROM 82 are a motion control program 82A for controlling the activation of the display 20, speaker 26, and motor 36; posture control data 82B for controlling the rotational direction and rotational amount of the motor 36 in accordance with the changes in the character at such time (value of happy mode or value of grumpy mode) and for switching the motion postures A-C; sound control data 82C for producing from the speaker 26 cries or melodies in accordance with the changes in the character at such time; display control data 82D for switching the display pattern of the display 20 in accordance with the changes in the character at such time; pet biorhythm data 82E for periodically changing the character (happy mode or grumpy mode); and biorhythm revision data 82F for periodically revising the pet biorhythm pursuant to the count value of the aforementioned detection signal.

The motion control program 82A stored in the ROM 82 includes a first control program for counting the number of detection signals output from the detection means which detects external inputs; second control program for changing the values of the parameter in accordance with prescribed time intervals; third control program for selecting an arbitrary motion pattern among a plurality of motion patterns pursuant to the number of detection signals and parameter values upon detection signals being output from the detection means;

and fourth control program for controlling the electronic toy to move in the selected motion pattern.

Further, stored in the RAM 84 are a counter 84A for counting the detection signals from the sound sensor 24, light sensor 25, and detection switch 59; and communication biorhythm data 84B prepared pursuant to the count value of the counter 84A.

With counter 84A, it is possible to set count mode 1 for counting, without selecting, the detection signals from the sound sensor 24, light sensor 25, and detection switch 59, and count mode 2 comprising first to third counters (not shown) for preparing communication biorhythm data for each sensor upon individually counting the detection signals from the sound sensor 24, light sensor 25, and detection switch 59, respectively.

The control processing executed by the CPU 80 of the controller 62 is now explained.

Further, the controller 62 includes sound generating circuitry as described herein to make the electronic toy 10 appear to make sounds in conjunction with the movement of the body parts so as enhance the ability of the toy to provide seemingly intelligent and life-like interaction with the user in that the electronic toy 10 can have different physical and emotional states as associated with different coordinated positions of the body parts and sounds or exclamations generated by the controller 62. The controller 62 also supports a magnetic switch for feeding functions associated with a bone 69 having a magnet 65 shown in FIG. 17A. Both the eye and mouth assemblies are mounted to the face frame member, as well as for the light and IR link sensor assembly. Thus, as shown in FIG. ~~17~~16, ~~and~~ IR transmitter 67 and an IR receiver 698 facilitate an infrared (IR) communications link. The infrared transmission with the LEDs is programmed using the information processor according to a pulse width modulated (PWM) signal protocol for communicating information from the information processor (controller) 62. The infrared signals generated from the LEDs may be coupled to the infrared receive block described below, or to another device in communication with the information processor 62. To this end, the infrared transmission block may be used for signal coupling to another computerized device, a personal computer, a computer network, the internet, or any other programmable computer interface. As previously discussed, the controller 62 utilizes inputs from the toy sensors for activating the motor. The audio sensor is in the form of a microphone mounted in cylindrical portion. The light sensor 25 and IR link assembly 67,68 are mounted behind an

opaque panel attached to the face frame. The light sensor portion of the assembly is mounted between an IR transmitter element 67 and an IR receiver element 68 on either side thereof to form the IR link to allow communication between a plurality of electronic toys 10.

An embodiment of an embedded processor circuit for the electronic toy, as shown in the schematic block diagram of FIG. 17, depicts the information processor provided as, e.g., an 8-bit reduced instruction set computer (RISC) controller, which is a CMOS integrated circuit providing the RISC processor with program/data read only memory (ROM). The information processor provides various functional controls facilitated with on board static random access memory (SRAM), a timer/counter, input and output ports (I/O) as well as an audio current mode digital to analog converter (DAC). DACs may also be used as output ports for generating signals for controlling various aspects of the circuitry as discussed further below. The information processor provides the IR transmission circuitry. The sound detection block 24 is used to allow the information processor 62 to receive audible information as sensory inputs from the child which is interacting with the electronic toy. The light detection block 25 is provided for sensory input to the information processor 62 through the use of a cadmium sulfide cell in an oscillator circuit for generating a varying oscillatory signal observed by the information processor 62 as proportional to the amount of ambient light.

As described, the plurality of sensory inputs, i.e., switches 66, and the audio 24, light 25, and infrared blocks 66,68, are coupled to the information processor 62 for receiving corresponding sensory signals. A computer program discussed below in connection with FIGS. 20 and 21, illustrates a program flow diagram for operating the embedded processor design facilitating processing of the sensory signals for operating the at least one actuator linkage responsive to the sensory signals from the child or the environment of the electronic toy. Accordingly, a plurality of operational modes of the electronic toy is provided by the computer program with respect to the actuator linkage operation and corresponding sensory signal processing for controlling the at least one actuator linkage to generate kinetic interaction with the child with the plurality of movable members corresponding to each of the operational modes of the electronic toy which provides interactive rudimentary artificial intelligence for the electronic toy.

FIG. 18 is a flowchart for explaining the control processing executed by the CPU 80 of the controller 62. FIG. 19 is a graph showing the changes in the pet biorhythm

and communication biorhythm. The CPU 80 repeatedly executes the control processing shown in FIG. 18 every 50 milliseconds, for example, pursuant to the motion control program 82A stored in the ROM 82.

As shown in FIG. 18, the CPU 80 confirms whether or not there was input from the sound sensor 24, light sensor 25, and detection switch 59 at step S11 (the term "step" is hereinafter omitted). When detection signals from the sound sensor 24, light sensor 25, and detection switch 59 are detected, the CPU 80 proceeds to S12, and adds 1 to the count value of the counter 84A. In the next S13, the lapsed time measured by the timer 86 is read. Next, the routine proceeds to S14, prepares ~~Graph II~~ Line 2 (see FIG. 19 explained later) of a communication biorhythm based on the counter value of the counter 84A, and updates the communication biorhythm data of the RAM 84. At S15, ~~Graph I~~ Line 1 (see FIG. 19 explained later) of the pet biorhythm data stored in the ROM 82 is read.

The routine then proceeds to S16, and extrudes parameters (value of happy mode, value of grumpy mode shown in FIGS. 20 and 21 explained later) from the relationship between the pet biorhythm data and communication biorhythm data (parameter alteration means). Next, at step S17, a motion pattern (1)-(12) (explained later with reference to FIGS. 20 and 21) is selected (selection means) based on the character data. At S18, the motor 36 is driven and controlled in accordance with the selected motion pattern and the legs 16-19 are moved to become the designated posture. Further, the display of the eyes by the display 20 is switched and cries or melodies are generated (control means) from the speaker 26. At S12, it is possible to count the count values of the respective sensors; i.e., sound sensor 24, light sensor 25, and detection switch 59, prepare a communication biorhythm graph in accordance with the respective count values, and control the posture, expression of the eyes by the display 20, and the cries from the speaker 26, and so on.

The relationship between the pet biorhythm and communication biorhythm is now explained. As shown in FIG. 19, in this embodiment, the control posture, cries, melodies, expression of the eyes, etc. of the electronic toy 10 are controlled pursuant to the relationship between ~~Graph I~~ Line1 of the pet biorhythm and ~~Graph II~~ Line 2 of the communication biorhythm. In FIG. 19 for the sake of convenience, changes in the pet biorhythm values are shown in ~~Graph I~~ Line 1 and changes in the communication biorhythm values are shown in ~~Graph II~~ Line 2. Nevertheless, the controller 62 conducts control

processing upon comparing the value showing parameter changes and the count value of the counter means.

The pet biorhythm is prepared by the data stored in the pet biorhythm data 82E and, as shown in ~~Graph I~~ Line 1 of FIG. 19, is set so as to periodically alternate (e.g., every 15 min.) between the happy mode (good character) and the grumpy mode (bad character). Further, in the happy mode and grumpy mode based on the pet biorhythm, the parameter values at such time change in a range of level 0 to 50 pursuant to the respective lapses in time.

As shown in ~~Graph II~~ Line 2 prepared by the data stored in the communication biorhythm data 84B, the communication biorhythm changes in accordance with the number of inputs to the sound sensor 24, light sensor 25, and detection switch 59 and the electronic toy 10 changes its movement or expression pursuant to the degree of the user's affection toward such electronic toy 10. Therefore, the electronic toy 10 is capable of changing its posture to motion postures A-C and the expression of the eyes by the display 20 (see FIGS. 8-10, FIG. 13) pursuant to the number of times the user contacts or speaks to the electronic toy 10.

When the contact frequency of the user, i.e., number of inputs to the sound sensor 24, light sensor 25, and detection switch 59, increases based on the biorhythm revision data 82F, the controller 62 changes the cycle by extending the happy mode and shortening the grumpy mode, or, if the number of inputs decreases, by extending the grumpy mode and shortening the happy mode. Thus, the happy mode and grumpy mode are not repeated in a fixed time period.

Therefore, as the electronic toy 10 will not make a uniform reaction even if contacted in a similar manner and will move and make expressions in accordance with the characteristic changes at such time, the user will not lose interest easily. As the user cannot predict the characteristic changes of the electronic toy 10, he/she may enjoy unexpected movements and expressions of the electronic toy 10.

For example, in the happy mode, when the character level is zero and the user strokes the head 12 of the electronic toy 10 and detection signals from the detection switch 59 are output; or the user speaks to the electronic toy 10 and detection signals from the sound sensor 24 are output; or the user waves his/her hand in front of the nose and detection signals from the light sensor 25 are output; notification event ① (cry ① is generated twice and heart

eyes are flashed on the display 20 (see FIG. 15)) is conducted to notify the user that the toy has entered the happy mode. Moreover, in the happy mode, while the character level of the pet biorhythm is changing from 0 to 50, for example, if the user makes five contacts (inputs) to the electronic toy 10, event ③ (bark ② and performance of special melody (Wedding March)) is conducted.

Also in the happy mode, when ~~Graph II~~ Line 2 of the communication biorhythm intersects with ~~Graph I~~ Line 1 of the pet biorhythm, event occurrence ① (sound effects and melody and commencement of slot game) is conducted. This slot game is a game wherein display patterns ①-⑨ are successively displayed on the display 20 and, when the speaker 26 is pushed and the detection switch 59 is turned on, any one of the display patterns ①-⑨ will stop and be displayed. Further in the happy mode, when the character level returns to zero due to the pet biorhythm, notification event ② (cry ② is generated twice and angry eyes are flashed on the display 20 (see FIG. 15)) is conducted and notifies the user that the toy has entered the grumpy mode.

In the grumpy mode, when ~~Graph II~~ Line 2 of the communication biorhythm intersects with ~~Graph I~~ Line 1 of the pet biorhythm, event occurrence ② (sound effects and melody and commencement of slot game) is conducted. Moreover, in the grumpy mode, when the character level of the pet biorhythm is near 50, the electronic toy 10 will become unresponsive to anything the user does, and extremely grumpy. For example, in response to the motion input of the user, angry eyes are displayed on the display 20 and a sigh is heaved. Also in the grumpy mode, when the character level of the pet biorhythm returns to zero, the aforementioned notification event ① (cry ① is generated twice and heart eyes are displayed on the display 20 (see FIG. 15)) is conducted and notifies the user that the toy has entered the happy mode. Although the counter 84A counts the number of inputs from the sound sensor 24, light sensor 25, and detection switch 59, when ~~Graph II~~ Line 2 of the communication biorhythm intersects with ~~Graph I~~ Line 1 of the pet biorhythm as described above, or when the count reaches a maximum value set in advance, the counter is reset and returned to zero.

The electronic toy 10 changes the posture and expression in accordance with the following motion patterns (1)-(12), for example, if inputs are made by the user when the toy is in the happy mode.

FIG. 20 is a diagram showing the control method of motions and expressions in accordance with the motion input from the respective sensors during the happy mode. As

shown in FIG. 20, for example, if inputs are made by the user when the character is in the happy mode, the electronic toy 10 changes the posture and expression in accordance with the motion patterns (1)-(12) as follows.

(1) When there is no input, motion posture B (see FIG. 9) is changed to motion posture A (see FIG. 8), the display is changed from round eyes to closed eyes on the display 20, and snoring is generated from the speaker 26.

(2) When there is input only from the sound sensor 24, the motion posture is changed from B to A, the display of closed eyes are changed to crying eyes on the display 20, and a joyful outcry is generated from the speaker 26.

(3) When there is input only from the light sensor 25, motion posture B is maintained, round eyes are displayed on the display 20, and monologues or sound effects are generated from the speaker 26.

(4) When there is input only from the detection switch 59, the motion posture is changed from B to C (see FIG. 10) and back to B, the display of closed eyes are changed to round eyes on the display 20, and a joyful outcry is generated from the speaker 26.

(5) When there are inputs from the sound sensor 24 and the light sensor 25, motion posture B is maintained, the display on the display 20 is changed to flashing round eyes, and the sound of a woof ① is generated from the speaker 26. Or, the motion posture is changed from B to C to B, heart eyes are displayed on the display 20, and a bark ① is generated from the speaker 26.

(6) When there are inputs from the sound sensor 24, light sensor 25, and detection sensor 59, the motion posture is changed from B to C to B to C to B, the display on the display 20 is changed from round eyes to heart eyes, or a wink is displayed on the display 20, and a laughing sound ① is generated from the speaker 26.

(7) When there are repeated inputs from the light sensor 25, motion posture B is maintained, the round eyes are made to flash on the display 20, and a joyful outcry and laughing sound ① are generated from the speaker 26.

(8) When there are repeated inputs from the sound sensor 24 and light sensor 25, the motion posture is changed from B to C to B to C to B, the heart eyes are made to flash on the display 20, and monologues ①-③ are generated from the speaker 26.

(9) When there are repeated inputs from the sound sensor 24, detection switch 59, and light sensor 25, the motion posture is changed from B to C to B to C to B, the

heart eyes are made to flash on the display 20, and a laughing sound and melody are generated from the speaker 26.

(10) When there are repeated inputs from the detection switch 59 and the light sensor 25, the motion posture is changed from B to C to B to C to B, the heart eyes are made to flash on the display 20k, and a joyful outcry and melody are generated from the speaker 26.

(11) When there are inputs from the sound sensor 24 and the detection switch 59, the motion posture is changed from B to A, the round eyes are made to flash on the display 20, and a monologue ② is generated from the speaker 26.

(12) When there are inputs from the light sensor 25 and detection witch 59, the motion posture is changed from B to C to B to C to B, the heart eyes are made to flash on the display 20, and a joyful outcry and melody are generated from the speaker 26.

As the character of this electronic toy 10 switches between the happy mode and grumpy mode in prescribed cycles based on the characteristic changes pursuant to the communication biorhythm, it is difficult for the user to predict the response of the toy to his/her input, and the user will thereby not lose interest in the toy.

It is also possible to change the cycle of the happy mode and/or the grumpy mode in accordance with the number of detections of the respective sensors. Thus, the cycle of the happy mode may be extended or the cycle of the grumpy mode may be extended pursuant to the way the user contacts the electronic toy 10. It will therefore be difficult for the user to predict the motion pattern at such time and will increase the amusement by the toy conducting unexpected actions.

The control processing of the initialization mode executed by the CPU 80 of the controller 62 is now explained.

FIG. 20 is a flowchart for explaining the initialization processing. As shown in FIG. 22, the CPU 80 of the controller 62 checks at S20 whether or not new batteries 58 have been installed. When the batteries 58 are initially installed in the battery housing 60 or when the batteries are replaced, the CPU 80 proceeds to S20, and resets the initialization value stored in the memory (not shown). Next, the initialization mode is set at S22. During this initialization mode, the electronic toy 10 has a character of a puppy, and is relatively good-tempered.

At the next S23, checked is whether or not there was input by a switch. Here, the CPU 80 monitors the detection motion of the sound sensor 24 and detection switch 59 as the detection means. When detection signals are output from the detection switch 59, the

routine proceeds to S24, integrates the detection frequency n thereof, and stores such integrated value (count value + 1) in the memory. At the subsequent S24, checked is whether prescribed time T (e.g., T=1 hour) has elapsed or not. Therefore, until 1 hour elapses from the time the batteries 58 were installed, the processing steps of S23-S25 are repeated. At S25, when 1 hour elapses, the routine proceeds to S26, and the count value n_A of the sound sensor 24 and the count value n_B of the detection switch 59 are compared.

VERSION WITH CHANGES

the first storage unit, sound patterns stored in the second storage unit, and expression patterns stored in the third storage unit. The selection of a combination of the posture motion pattern, sound pattern, and expression pattern stored in the memory facilitates selection of a combination of the posture motion pattern, sound pattern, and expression pattern. The expression pattern includes a motion pattern for changing at least the size or the shape of the eyes. Thus, produced is an expression according to the changes in the character at such time. The electronic toy is thus capable of controlling motions arbitrarily in accordance with external inputs with a head housing a drive motor and a transmission mechanism for transmitting rotational driving force to the drive motor, a display for displaying the shape of the eyes and provided from the front of the head, first detection means provided on the top of the head and for detecting the pressing thereof, second detection means for detecting sound, third detection means for detecting the peripheral brightness, a body housing a cam mechanism ,which is driven by rotational driving force from said drive motor via the transmission mechanism, legs driven by said cam mechanism, a lower jaw driven by said transmission mechanism, ears driven by said transmission mechanism, storage means for storing the respective motion patterns of the legs, lower jaw, and ears, and a controller for selecting an arbitrary motion pattern among the plurality of motion patterns stored in the storage means in accordance with the timing of detection signals output from the first to third detection means, and controlling the drive motor and the display pattern of the display in accordance with the selected motion pattern. Arbitrary motion patterns are then selected among a plurality of motion patterns stored in the storage means according to the timing of the detection signals output from the first through third detection means, and as the drive motor and the display pattern of the display are controlled according to the selected motion pattern.

The electronic toy arbitrarily controls motions in accordance with external inputs by setting the initial mode for a period after the power is turned on until a prescribed time elapses, detecting external inputs while the initial mode is initialized such that the individual differences of gender and the like may be determined pursuant to the number of times the user contacts the toy while the initialization mode is being set after the batteries are foremost installed. This enables the production as though the electronic toy has a gender and character of an animal as individual differences will appear with respect to the expression, sound, and motion in correspondence with the contact of the user after initialization. The

individual difference setting means sets individual differences pursuant to whether the count value of the counter is an add or even number. Accordingly, individual differences are set pursuant to whether the count value of the number of inputs detected during the setting of the initialization mode is an odd or even number. This further enables the production as though the electronic toy has a gender and character of an animal as individual differences will appear with respect to the expression, sound, and motion in correspondence with the contact of the user after initialization. The electronic toy may also be provided with gender and like characteristics of an animal as individual differences appear with respect to the expression, sound, and motion in correspondence with the contact of the user after initialization.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiments of the present invention are now explained with reference to the drawings.

FIG. 1 is a front view of the electronic toy according to an embodiment of the present invention;

FIG. 2 is a side view of the electronic toy shown in FIG. 1;

FIG. 3 is a plan view of the electronic toy shown in FIG. 1;

FIG. 4 is a rear view of the electronic toy shown in FIG. 1;

FIG. 5 is a bottom view of the electronic toy shown in FIG. 1;

FIG. 6 is a perspective view of the electronic toy shown in FIG. 1;

FIG. 7 is a side view of the electronic toy showing the rotational direction and rotational angle of the legs;

FIG. 8 is a side view showing the motional state when the electronic toy is in the sleeping posture A;

FIG. 9 is a side view of the motional state when the electronic toy is in the standing posture B;

FIG. 10 is a side view of the motional state when the electronic toy is in the leaning-forward posture C;

FIG. 11 is a front-vertical cross section showing the internal structure of the electronic toy;

FIG. 12 is a side-vertical cross section showing the internal structure of the electronic toy;

FIG. 13 is a plan-vertical cross section showing the internal structure of the electronic toy;

FIG. 14 is a front view separately showing the red acryl plates built in the display;

FIG. 15 is a diagram showing the combinations of the display patterns to be illuminated and displayed on the display;

FIG. 16 is a block diagram showing the structure of the control system of the electronic toy;

FIG. 17 is a block diagram showing the structure of the controller;

FIG. 17A illustrates a feeding device in the form of a bone containing magnetic material;

FIG. 18 is a flowchart for explaining the control processing executed by the CPU 80 of the controller;

FIG. 19 is a graph showing the changes in the pet biorhythm and communication biorhythm with control method of motions and expressions in accordance with the motional input from the respective sensors during the happy mode;

FIG. 20 is a flowchart for explaining the initialization processing; and

FIG. 21 is a flowchart for explaining a modified example of the initialization processing;

FIG. 22 shows male and female gender data associated with eye patterns A and B shown in FIGS. 23 and 24 respectively, with associated voice and song gender characteristics;

FIG. 25 is a front view of the electronic toy according to the second embodiment of the present invention;

FIG. 26 is a side view of the electronic toy shown in FIG. 25;

FIG. 27 is a plan view of the electronic toy shown in FIG. 25;

FIG. 28 is a rear view of the electronic toy shown in FIG. 25;

FIG. 29 is a bottom view of the electronic toy shown in FIG. 25;

FIG. 30 is a perspective view of the electronic toy shown in FIG. 25;

FIG. 31 is a diagram showing the combinations of motion types of the electronic toy 90 and the motion positions of the legs 16-19; (A) is a diagram showing the

combinations of the motion types and the motion positions of the legs 16-19; and (B) is a diagram respectively showing the rotation angles of the legs 16-19;

FIG. 32 is a side view for explaining a motion of "stand" of the electronic toy 90;

FIG. 33 is a side view for explaining a motion of "sit" of the electronic toy 90;

FIG. 34 is a side view for explaining a motion of "hand" of the electronic toy 90;

FIG. 35 is a side view for explaining a motion of "lie down" of the electronic toy 90;

FIG. 36 is a diagram showing an example of the display patterns on the display 20; (A) is a diagram showing smiling eyes; (B) is a diagram showing ? eyes; (C) is a diagram showing heart-shaped eyes; (D) is a diagram showing melancholy eyes; and (E) is a diagram showing round eyes;

FIG. 37 is a diagram for explaining a sound registration; (A) is a diagram showing an example of registered words to be used in sound registration; (B) is a flowchart for explaining the steps of sound registration; (C) is a flowchart for explaining an unsuccessful example of sound registration; and (D) is a flowchart for explaining a successful example of sound registration;

FIG. 38 is a diagram for explaining an example of conditions for character formation; (A) is a diagram showing the characteristics of the characters; (B) is a diagram showing an example of the character formation parameter MAP; and (C) is a diagram showing an example of conditions for character changing;

FIG. 39 is a diagram for explaining an example of character registration motions; (A) is a diagram showing an example of an incorrect motion; and (B) is a diagram showing an example of a correct motion;

FIG. 40 is a graph showing the characters set in accordance with the variation (increase) of the number of points in a faithful dog parameter I and a performing dog parameter II which are registered in the character formation parameter MAP 102; (A) is a graph showing a faithful dog setting mode; (B) is a graph showing a performing dog setting mode; and (C) and (D) are graphs showing cur setting modes;

FIG. 41 is a diagram explaining the mood parameters; (A) indicates the level of the mood parameter; (B) indicates the state of the respective level; (C) indicates positive

conditions to the mood parameter; and (D) indicates negative conditions to the mood parameter;

FIG. 42 is a diagram explaining the fullness parameters; (A) indicates the level of a fullness parameter; (B) indicates the state of the respective level; and (C) indicates positive conditions to the fullness parameter, and (D) indicates negative conditions to the fullness parameter;

FIG. 43 is a graph showing an example of the mood parameter changes;

FIG. 44 is a graph showing an example of the changing values of the mood parameter in accordance with the fullness parameter value P_B;

FIG. 45 is a flowchart of the main processing executed by the controller 62 of the electronic toy 90; and

FIG. 46 is a flowchart of the main processing executed following the processing of FIG. 45.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIGS. 1 through 6, the electronic toy 10 is a dog-shaped toy having, in summary, a head 12, body 14, and legs 16-19. Although the electronic toy 10 of this embodiment is structured such that the four legs 16-19 are provided to both sides of the body 14, it does not walk. That is, the electronic toy 10 is structured to change its posture by the rotational motion of the legs 16-19 by rotating such legs 16-19 at a prescribed angle in accordance with the changes in the feeling as described later.

The four legs 16-19 are respectively formed of circular axes 16a-19a rotatably supported at both sides of the body 14, shanks 16b-19b extending in the radial direction from the axes 16a-19a, and toes 16c-19c provided at the tip of the shanks 16b-19b.

Moreover, the legs 16-19, axes 16a-19a, shanks 16b-19b, and toes 16c-19c are formed integrally, and joints different from those of actual dogs are not provided to the legs 16-19. Semispherical caps 16d-19d are provided to the side of the axes 16a-19a, and these caps 16d-19d may be colored an arbitrary color.

A display 20 for displaying the expression of the eyes is provided to the front of the head 12. Although this display 20 ordinarily displays oval eyes pursuant to the illumination of light emitting diodes (LED), a plurality of LEDs may be selectively illuminated as explained later in order to change the display pattern of the eyes for expressing the feeling at such time.

A sound sensor 24 (sound detection means) structured of a microphone for detecting peripheral sounds is built in the tip face of the nose 22 protruding frontward from the front of the head 12. A light sensor 25 for detecting the peripheral brightness is stored in the upper corner of the nose 22. The light sensor of the present embodiment, for example, is formed of CdS cells (cadmium sulfide cells) and outputs detection signals in accordance with the brightness of the incoming light.

A speaker 26 for producing barking sounds or playing melodies is provided to the upper face of the head 12. This speaker 26 is mounted slidably in the upward/downward directions as described later and, for example, when the head 12 is pushed, the speaker 26 is moved downward so as to detect that the toy has been stroked.

On both sides of the head 12, provided are ears 28 formed of semi-transparent material colored an arbitrary color different than that of the head 12. The upper part of the ears 28 are connected rotatably to the side of the head 12 and, as explained later, rotates upward or downward in accordance with the changes in the feeling at such time.

A lower jaw 30 at the lower side of the nose 22 is provided rotatably to be in an opened position or closed position and operates with the mouth 31 in an open state or closed state in accordance with the changes in the feeling at such time.

A tail 32 is provided to the rear of the body 14 so as to move upward or downward in accordance with the changes in the feeling at such time.

The motion patterns of the electronic toy 10 structured as above are explained below. As shown in FIG. 7, the front legs 16 and 17 among the legs 16-19 are provided such that they are capable of being positioned in motion position A rotated 60 degrees in the forward direction (a direction) from standstill position B, and in motion position C rotated 30 degrees in the backward direction (b direction) from standstill position B. Moreover, the hind legs 18 and 19 are provided such that they are capable of being positioned in motion position A rotated 90 degrees in the forward direction (a direction) from standstill position B, and in motion position C rotated 45 degrees in the backward direction from standstill position B.

FIG. 8 is a side view showing the motional state when the electronic toy 10 is in the sleeping posture A. As shown in FIG. 8, when the electronic toy 10 is in the sleeping posture A, the respective legs 16-19 are rotated to motion position A. Thus, the respective legs 16-19 are extending forward along both sides of the body 14, the bottom of the body 14

is near the floor 34, and the electronic toy 10 is therefore in posture A. Therefore, the electronic toy 10 may express with its entire body the feeling of, for example, sleepiness or gloominess, by taking posture A described above.

FIG. 9 is a side view of the motional state when the electronic toy 10 is in standing position B. As shown in FIG. 9, when the electronic toy 10 is in the standing posture B, the respective legs 16-19 are rotated to motion position B. Thus, the respective legs 16-19 are rotated to a position (standstill position B) such that they extend downward from both sides of the body 14, the bottom of the body 14 is far from the floor 34, and the electronic toy 10 is therefore posture B. Further, during posture B, the whole surface of the bottom of the respective legs 16-19 (bottom of feet) is closely contacting the floor 34. Therefore, the electronic toy 10, for example, when it is not doing anything, maintains the aforementioned standing posture B in ordinary situations.

FIG. 10 is a side view of the motional state when the electronic toy 10 is in the leaning-forward posture C. As shown in FIG. 10, when the electronic toy is in the leaning-forward posture C, the respective legs 16-19 are at motion position C by being rotated in the b direction with respect to posture B. Thus, the respective legs 16-19 become a posture similar to a tiptoe by standing on the tip of the toes 16c-19c, the heels of the respective legs 16-19 will rise from the floor 34, and the electronic toy is therefore in posture C. During posture C, the lower jaw 30 is rotated in the lower direction c direction) in order to open the mouth, and the tail 32 is rotated in the upward direction (d direction). Moreover, the ears 28 shown in FIG. 1 will rotate in the upward direction (e direction). Therefore, the electronic toy 10 may express with its entire body the feeling of, for example, happiness or pleasure by taking posture C described above.

With the electronic toy of this embodiment, the motion patterns of the three types of postures A-C described in aforementioned FIGS. 8-10 are the basic motions. The internal structure of the electronic toy 10 is now described.

FIG. 11 is a front-vertical cross section showing the internal structure of the electronic toy 10. FIG. 12 is a side-vertical cross section showing the internal structure of the electronic toy 10. FIG. 13 is a plan-vertical cross section showing the internal structure of the electronic toy 10.

As shown in FIGS. 11 through 13, the electronic toy 10 internally comprises in the head 12 a motor 36 and a transmission mechanism (transmission means) 38 for

transmitting the rotational driving force of the motor 36 to the legs 16-19, ears 28, lower jaw 30, and tail 32. The aforementioned legs 16-19, ears 28, lower jaw 30, and tail 32 are respectively driven by one motor 36, and are selectively transmitted the rotational driving force of the motor 36 by the transmission mechanism 38 in accordance with the aforementioned postures A, B, and C.

The motor 36 and transmission mechanism 38 are supported by the bracket 41 provided inside the head 12 and body 14. Therefore, the motor 36 and transmission mechanism 38 are of a compact structure, and are made to correspond to the miniaturization of the electronic toy 10.

Further, the transmission mechanism 38 comprises: a drive gear 40 mounted on the drive axis 36a of the motor 36; a first transmission gear 42 for engaging with the drive gear 40; a second transmission gear 44 for engaging with the first transmission gear 42; a third transmission gear 46 for engaging with the second transmission gear 44; a fourth transmission gear 47 for engaging with the third transmission gear 46; a first cam gear 48 co-axially provided with the fourth transmission gear 47; a first shaft 50 for supporting the first cam gear 48; a fifth transmission gear 52 for supporting the first shaft 50; and a second cam gear 54 for engaging with the fifth transmission gear 52.

Transmission gears 42, 44, 46 are respectively structured of large-diameter gears 42a, 44a, 46a and small-diameter gears 42b, 44b, 46b formed integrally, and decelerate the rotation from the motor 36 at a prescribed deceleration ratio. Moreover, the bracket 41 supports the axes 42c, 44c, 46c to which the respective transmission gears 42, 44, 46 are engaged.

The first cam gear 48 is a driving means for driving the front legs 16, 17, and is formed to rotate such legs 16, 17 to the aforementioned rotational positions A, B, C in accordance with the rotational directions and rotational amounts of the drive axis 36a of the motor 36. The third and fourth cam gears 54, 55 are driving means for driving the hind legs 18, 19, and are formed to rotate such legs 18, 19 to the aforementioned rotational positions A, B, C in accordance with the rotational directions and rotational amounts of the drive axis 36a of the motor 36.

The second cam gear 54 drives the tail 32, and is also connected to the transmission path 56 for driving the ears 28 and lower jaw 30. This transmission path 56 is formed, for example, from a wire and pulley etc. as shown with the one-point chain lines and

rotates the ears 28, lower jaw 30 and tail 32 in the e, c, and d directions during the process of rotating the legs 18, 19 from motion position B to motion position C pursuant to the rotational angle of the second cam gear 54.

A battery housing 60 for housing batteries 58 as the power source is internally provided to the head 12. A substrate 64 having a controller 62 mounted thereon is housed inside the nose 22. A speaker 26 is provided slidably in the upward/downward directions, and comprises thereunder a push-type detection switch (contact detection switch) 59 for detecting that the speaker 26 has been pushed and moved downward.

The detection switch 59 is for detecting the lowering of the speaker 26 by the user stroking or knocking on the head 12, and is capable of making such detection while being insensible to the contact made by the user.

The motor 36 and batters 58, which are comparatively heavy among the aforementioned structural components, are arranged at a position near the centroid of the electronic toy 10; that is, at the approximate center of the head 12. The electronic toy 10 is therefore able to maintain the respective postures with steadiness.

Next, the structure of the display 20 for displaying the expression of the eyes is explained. A black smoke plate 68 is mounted on the front display 20, and four red acryl plates 71-74 of end face-illumination are layered on the inside of the smoke plate 68. Light emitting diodes (LEDs) 75-79 are arranged at the upper and lower parts of the respective red acryl plates 71-74. Other than the end face-illumination type described above, other forms of display devices (e.g., liquid crystal displays with back lights, etc.) may be used as the display 20.

FIGS. 14(A)-14(D) are front views separately showing the red acryl plates built in the display 20. As shown in FIG. 14(A), the red acryl plate 71 comprises illuminators 71a, 71b arranged in an oval shape with the bottom parts removed. These illuminators 71a, 71b have small holes provided in prescribed intervals, and red light is emitted from the inner walls of the respective small holes when light from the LEDs 75, 76 enters the entrance 71c provided on the end face. Therefore, the upper parts of the left and right eyes will illuminate in an upside down U-shape pursuant to the illumination of the illuminators 71a, 71b.

A screen 71e for blocking the light is provided between the illuminators 71a and 71b. Thus, when light is emitted from only one of the LEDs 75, 76, one of the illuminators 71a, 71b will illuminate and produce the effect of a wink.

As shown in FIG. 14(B), the red acryl plate 72 comprises illuminators 72a, 72b arranged in a heart shape. These illuminators 72a, 72b have small holes provided in a heart shape in prescribed intervals, and red light is emitted from the inner walls of the respective small holes when light from the LED 77 enters the entrance 72c provided on the end face. Thus, the left and right eyes will illuminate in a heart shape by the illuminators 72a, 72b illuminating.

As shown in FIG. 14(C), the red acryl plate 73 comprises illuminators 73a, 73b arranged in a small semicircular shape formed continuously at the lower part of the illuminators 71a, 71b shown in FIG. 14(A). These illuminators 73a, 73b have small holes provided in a semicircular shape in prescribed intervals, and red light is emitted from the inner walls of the respective small holes when light from the LED 78 enters the entrance 73c provided to the end face. Thus, the left and right eyes will illuminate as small, angry eyes by the illuminators 73a, 73b illuminating.

As shown in FIG. 14(D), the red acryl plate 74 comprises illuminators 74a, 74b arranged radially in small points formed continuously at the lower part of the illuminators 71a, 71b shown in FIG. 14(A). Regarding these illuminators 74a, 74b, red light is emitted from the inner walls of the respective small holes when light from the LED 79 enters the entrance 74c provided at the end face. Thus, the left and right eyes will illuminate as crying eyes by the illuminators 73a, 73b illuminating.

The arrangement of the aforementioned LEDs 75-79 is such that the LEDs are distributed at the upper or lower parts of the red acryl plates 71-74 so that light will not enter into other adjacent red acryl plates, and are covered with a partition wall (not shown) for preventing the light from leaking into its periphery. Thereby, the respective display patterns will not interfere with each other even when the red acryl plates 71-74 are superposed, and it is further possible to place such plates 71-74 in a small space inside the head 12.

FIG. 15 is a diagram showing the combinations of the display patterns to be illuminated and displayed on the display 20. As shown in FIG. 15, the display 20, for example, is capable of selectively displaying nine (9) types of display patterns ①-⑨. In display pattern ①, the LED 77 is lit and illuminators 72a, 72b arranged in a heart shape are illuminated. In display pattern ②, the LED 76 is lit and the illuminator 71b of the upper right eye is illuminated. In display pattern ③, the LED 78 is lit and illuminators 73a, 73b of the left and right angry eyes are illuminated. In display pattern ④, LEDs 75, 78 are lit and the

illuminator 71a of the left eye is illuminated, and illuminator 73a, 73b of the left and right angry eyes are also illuminated to display the right-eyed wink. In display pattern ⑤, LEDs 75, 76, 79 are lit and illuminators 71a, 71b of both eyes are illuminated, and illuminators 74a, 74b representing tears in both eyes are illuminated to display crying eyes. In display pattern ⑥, LEDs 75, 76, 78 are lit and illuminators 71a, 71b of the left and right upper round eyes are illuminated, and illuminators 73a, 73b of the left and right lower round eyes are illuminated to display the overall oval-shaped round eyes. In display pattern ⑦, the LED 75 is lit and the illuminator 71a of the left upper round eye is illuminated. In display pattern ⑧, LEDs 76, 78 are lit and the illuminator 71b of the right eye is illuminated, and illuminators 73a, 73b of the left and right angry eyes are also illuminated to display the left-eyed wink. In display pattern ⑨, the respective LEDs 75-79 are turned off so that no illumination is displayed on the display 20.

At the display 20, lighting control of the respective LEDs 75-79 is conducted pursuant to control signals from the controller 62. This produces changes in the emotions at such time by representing the expressions with any one of the aforementioned nine (9) types of display patterns ①-⑨.

The structure of the control system of the aforementioned electronic toy 10 is described below.

FIG. 16 is a block diagram showing the structure of the control system of the electronic toy 10. As shown in FIG. 16, the controller 62 is connected to the display 20, sound sensor 24, light sensor 25, speaker 26, motor 36, battery 58, detection switch 59, and, as described later, counts the detection signals from the sound sensor 24, light sensor 25, detection switch 59. The controller 62 thereby drives and controls the display 20, speaker 26, and motor 36 by extracting control data from the relationship of the count value and elapsed time.

Various artificial intelligence (AI) functions and sensor training are provided in which training between the random and sequential behavior modifications of the electronic toy allows the child to provide reinforcement of desirable activities and responses. In connection with the AI functions, appropriate responses are performed for particular activities or conditions, e.g., bored, hungry, sick, sleep. Such predefined conditions have programmed responses which are undertaken by the electronic toy at appropriate times in its operative states. The AI and sensory training functions achieve behavior modification for the

interactive toy, thus allowing the child to provide reinforcement of desirable activities and responses. The AI functions are used for the appropriate responses to particular activities or predefined conditions undertaken by the interactive toy at appropriate times in its operative states. Additionally, as discussed, the interactive toy maintains its age in a non-volatile memory, which is used to increment the age where appropriate. Additionally, a co-processor facilitates infrared (IR) communications allowing for communications between electronic toys as discussed herein. Other criteria based on the electronic toy's life as stored in memory may affect the ability to play games. For instance, if the electronic toy is indicated as being sick, either by having received a signal from another electronic toy to enter the sick condition, then no game would be played.

FIG. 17 is a block diagram showing the structure of the controller 62. As shown in FIG. 17, the controller 62 comprises a CPU 80 as the central processing unit, ROM 82 (storage means; first-third storage units), RAM 84, and timer 86. Stored in the ROM 82 are a motion control program 82A for controlling the activation of the display 20, speaker 26, and motor 36; posture control data 82B for controlling the rotational direction and rotational amount of the motor 36 in accordance with the changes in the character at such time (value of happy mode or value of grumpy mode) and for switching the motion postures A-C; sound control data 82C for producing from the speaker 26 cries or melodies in accordance with the changes in the character at such time; display control data 82D for switching the display pattern of the display 20 in accordance with the changes in the character at such time; pet biorhythm data 82E for periodically changing the character (happy mode or grumpy mode); and biorhythm revision data 82F for periodically revising the pet biorhythm pursuant to the count value of the aforementioned detection signal.

The motion control program 82A stored in the ROM 82 includes a first control program for counting the number of detection signals output from the detection means which detects external inputs; second control program for changing the values of the parameter in accordance with prescribed time intervals; third control program for selecting an arbitrary motion pattern among a plurality of motion patterns pursuant to the number of detection signals and parameter values upon detection signals being output from the detection means; and fourth control program for controlling the electronic toy to move in the selected motion pattern.

Further, stored in the RAM 84 are a counter 84A for counting the detection signals from the sound sensor 24, light sensor 25, and detection switch 59; and communication biorhythm data 84B prepared pursuant to the count value of the counter 84A.

With counter 84A, it is possible to set count mode 1 for counting, without selecting, the detection signals from the sound sensor 24, light sensor 25, and detection switch 59, and count mode 2 comprising first to third counters (not shown) for preparing communication biorhythm data for each sensor upon individually counting the detection signals from the sound sensor 24, light sensor 25, and detection switch 59, respectively.

The control processing executed by the CPU 80 of the controller 62 is now explained.

Further, the controller 62 includes sound generating circuitry as described herein to make the electronic toy 10 appear to make sounds in conjunction with the movement of the body parts so as enhance the ability of the toy to provide seemingly intelligent and life-like interaction with the user in that the electronic toy 10 can have different physical and emotional states as associated with different coordinated positions of the body parts and sounds or exclamations generated by the controller 62. The controller 62 also supports a magnetic switch for feeding functions associated with a bone 69 having a magnet 65 shown in FIG. 17A. Both the eye and mouth assemblies are mounted to the face frame member, as well as for the light and IR link sensor assembly. Thus, as shown in FIG. 16, IR transmitter 67 and an IR receiver 68 facilitate an infrared (IR) communications link. The infrared transmission with the LEDs is programmed using the information processor according to a pulse width modulated (PWM) signal protocol for communicating information from the information processor (controller) 62. The infrared signals generated from the LEDs may be coupled to the infrared receive block described below, or to another device in communication with the information processor 62. To this end, the infrared transmission block may be used for signal coupling to another computerized device, a personal computer, a computer network, the internet, or any other programmable computer interface. As previously discussed, the controller 62 utilizes inputs from the toy sensors for activating the motor. The audio sensor is in the form of a microphone mounted in cylindrical portion. The light sensor 25 and IR link assembly 67,68 are mounted behind an opaque panel attached to the face frame. The light sensor portion of the assembly is mounted between an

IR transmitter element 67 and an IR receiver element 68 on either side thereof to form the IR link to allow communication between a plurality of electronic toys 10.

An embodiment of an embedded processor circuit for the electronic toy, as shown in the schematic block diagram of FIG. 17, depicts the information processor provided as, e.g., an 8-bit reduced instruction set computer (RISC) controller, which is a CMOS integrated circuit providing the RISC processor with program/data read only memory (ROM). The information processor provides various functional controls facilitated with on board static random access memory (SRAM), a timer/counter, input and output ports (I/O) as well as an audio current mode digital to analog converter (DAC). DACs may also be used as output ports for generating signals for controlling various aspects of the circuitry as discussed further below. The information processor provides the IR transmission circuitry. The sound detection block 24 is used to allow the information processor 62 to receive audible information as sensory inputs from the child which is interacting with the electronic toy. The light detection block 25 is provided for sensory input to the information processor 62 through the use of a cadmium sulfide cell in an oscillator circuit for generating a varying oscillatory signal observed by the information processor 62 as proportional to the amount of ambient light.

As described, the plurality of sensory inputs, i.e., switches 66, and the audio 24, light 25, and infrared blocks 66,68, are coupled to the information processor 62 for receiving corresponding sensory signals. A computer program discussed below in connection with FIGS. 20 and 21, illustrates a program flow diagram for operating the embedded processor design facilitating processing of the sensory signals for operating the at least one actuator linkage responsive to the sensory signals from the child or the environment of the electronic toy. Accordingly, a plurality of operational modes of the electronic toy is provided by the computer program with respect to the actuator linkage operation and corresponding sensory signal processing for controlling the at least one actuator linkage to generate kinetic interaction with the child with the plurality of movable members corresponding to each of the operational modes of the electronic toy which provides interactive rudimentary artificial intelligence for the electronic toy.

FIG. 18 is a flowchart for explaining the control processing executed by the CPU 80 of the controller 62. FIG. 19 is a graph showing the changes in the pet biorhythm and communication biorhythm. The CPU 80 repeatedly executes the control processing

shown in FIG. 18 every 50 milliseconds, for example, pursuant to the motion control program 82A stored in the ROM 82.

As shown in FIG. 18, the CPU 80 confirms whether or not there was input from the sound sensor 24, light sensor 25, and detection switch 59 at step S11 (the term "step" is hereinafter omitted). When detection signals from the sound sensor 24, light sensor 25, and detection switch 59 are detected, the CPU 80 proceeds to S12, and adds 1 to the count value of the counter 84A. In the next S13, the lapsed time measured by the timer 86 is read. Next, the routine proceeds to S14, prepares Line 2 (see FIG. 19 explained later) of a communication biorhythm based on the counter value of the counter 84A, and updates the communication biorhythm data of the RAM 84. At S15, Line 1 (see FIG. 19 explained later) of the pet biorhythm data stored in the ROM 82 is read.

The routine then proceeds to S16, and extrudes parameters (value of happy mode, value of grumpy mode shown in FIGS. 20 and 21 explained later) from the relationship between the pet biorhythm data and communication biorhythm data (parameter alteration means). Next, at step S17, a motion pattern (1)-(12) (explained later with reference to FIGS. 20 and 21) is selected (selection means) based on the character data. At S18, the motor 36 is driven and controlled in accordance with the selected motion pattern and the legs 16-19 are moved to become the designated posture. Further, the display of the eyes by the display 20 is switched and cries or melodies are generated (control means) from the speaker 26. At S12, it is possible to count the count values of the respective sensors; i.e., sound sensor 24, light sensor 25, and detection switch 59, prepare a communication biorhythm graph in accordance with the respective count values, and control the posture, expression of the eyes by the display 20, and the cries from the speaker 26, and so on.

The relationship between the pet biorhythm and communication biorhythm is now explained. As shown in FIG. 19, in this embodiment, the control posture, cries, melodies, expression of the eyes, etc. of the electronic toy 10 are controlled pursuant to the relationship between Line1 of the pet biorhythm and Line 2 of the communication biorhythm. In FIG. 19 for the sake of convenience, changes in the pet biorhythm values are shown in Line 1 and changes in the communication biorhythm values are shown inLine 2. Nevertheless, the controller 62 conducts control processing upon comparing the value showing parameter changes and the count value of the counter means.

The pet biorhythm is prepared by the data stored in the pet biorhythm data 82E and, as shown in Line 1 of FIG. 19, is set so as to periodically alternate (e.g., every 15 min.) between the happy mode (good character) and the grumpy mode (bad character). Further, in the happy mode and grumpy mode based on the pet biorhythm, the parameter values at such time change in a range of level 0 to 50 pursuant to the respective lapses in time.

As shown in Line 2 prepared by the data stored in the communication biorhythm data 84B, the communication biorhythm changes in accordance with the number of inputs to the sound sensor 24, light sensor 25, and detection switch 59 and the electronic toy 10 changes its movement or expression pursuant to the degree of the user's affection toward such electronic toy 10. Therefore, the electronic toy 10 is capable of changing its posture to motion postures A-C and the expression of the eyes by the display 20 (see FIGS. 8-10, FIG. 13) pursuant to the number of times the user contacts or speaks to the electronic toy 10.

When the contact frequency of the user, i.e., number of inputs to the sound sensor 24, light sensor 25, and detection switch 59, increases based on the biorhythm revision data 82F, the controller 62 changes the cycle by extending the happy mode and shortening the grumpy mode, or, if the number of inputs decreases, by extending the grumpy mode and shortening the happy mode. Thus, the happy mode and grumpy mode are not repeated in a fixed time period.

Therefore, as the electronic toy 10 will not make a uniform reaction even if contacted in a similar manner and will move and make expressions in accordance with the characteristic changes at such time, the user will not lose interest easily. As the user cannot predict the characteristic changes of the electronic toy 10, he/she may enjoy unexpected movements and expressions of the electronic toy 10.

For example, in the happy mode, when the character level is zero and the user strokes the head 12 of the electronic toy 10 and detection signals from the detection switch 59 are output; or the user speaks to the electronic toy 10 and detection signals from the sound sensor 24 are output; or the user waves his/her hand in front of the nose and detection signals from the light sensor 25 are output; notification event ① (cry ① is generated twice and heart eyes are flashed on the display 20 (see FIG. 15)) is conducted to notify the user that the toy has entered the happy mode. Moreover, in the happy mode, while the character level of the pet biorhythm is changing from 0 to 50, for example, if the user makes five contacts (inputs)

to the electronic toy 10, event ③ (bark ② and performance of special melody (Wedding March)) is conducted.

Also in the happy mode, when Line 2 of the communication biorhythm intersects with Line 1 of the pet biorhythm, event occurrence ① (sound effects and melody and commencement of slot game) is conducted. This slot game is a game wherein display patterns ①-⑨ are successively displayed on the display 20 and, when the speaker 26 is pushed and the detection switch 59 is turned on, any one of the display patterns ①-⑨ will stop and be displayed. Further in the happy mode, when the character level returns to zero due to the pet biorhythm, notification event ② (cry ② is generated twice and angry eyes are flashed on the display 20 (see FIG. 15)) is conducted and notifies the user that the toy has entered the grumpy mode.

In the grumpy mode, when Line 2 of the communication biorhythm intersects with Line 1 of the pet biorhythm, event occurrence ② (sound effects and melody and commencement of slot game) is conducted. Moreover, in the grumpy mode, when the character level of the pet biorhythm is near 50, the electronic toy 10 will become unresponsive to anything the user does, and extremely grumpy. For example, in response to the motion input of the user, angry eyes are displayed on the display 20 and a sigh is heaved. Also in the grumpy mode, when the character level of the pet biorhythm returns to zero, the aforementioned notification event ① (cry ① is generated twice and heart eyes are displayed on the display 20 (see FIG. 15)) is conducted and notifies the user that the toy has entered the happy mode. Although the counter 84A counts the number of inputs from the sound sensor 24, light sensor 25, and detection switch 59, when Line 2 of the communication biorhythm intersects with Line 1 of the pet biorhythm as described above, or when the count reaches a maximum value set in advance, the counter is reset and returned to zero.

The electronic toy 10 changes the posture and expression in accordance with the following motion patterns (1)-(12), for example, if inputs are made by the user when the toy is in the happy mode.

FIG. 20 is a diagram showing the control method of motions and expressions in accordance with the motion input from the respective sensors during the happy mode. As shown in FIG. 20, for example, if inputs are made by the user when the character is in the happy mode, the electronic toy 10 changes the posture and expression in accordance with the motion patterns (1)-(12) as follows.

(1) When there is no input, motion posture B (see FIG. 9) is changed to motion posture A (see FIG. 8), the display is changed from round eyes to closed eyes on the display 20, and snoring is generated from the speaker 26.

(2) When there is input only from the sound sensor 24, the motion posture is changed from B to A, the display of closed eyes are changed to crying eyes on the display 20, and a joyful outcry is generated from the speaker 26.

(3) When there is input only from the light sensor 25, motion posture B is maintained, round eyes are displayed on the display 20, and monologues or sound effects are generated from the speaker 26.

(4) When there is input only from the detection switch 59, the motion posture is changed from B to C (see FIG. 10) and back to B, the display of closed eyes are changed to round eyes on the display 20, and a joyful outcry is generated from the speaker 26.

(5) When there are inputs from the sound sensor 24 and the light sensor 25, motion posture B is maintained, the display on the display 20 is changed to flashing round eyes, and the sound of a woof ① is generated from the speaker 26. Or, the motion posture is changed from B to C to B, heart eyes are displayed on the display 20, and a bark ① is generated from the speaker 26.

(6) When there are inputs from the sound sensor 24, light sensor 25, and detection sensor 59, the motion posture is changed from B to C to B to C to B, the display on the display 20 is changed from round eyes to heart eyes, or a wink is displayed on the display 20, and a laughing sound ① is generated from the speaker 26.

(7) When there are repeated inputs from the light sensor 25, motion posture B is maintained, the round eyes are made to flash on the display 20, and a joyful outcry and laughing sound ① are generated from the speaker 26.

(8) When there are repeated inputs from the sound sensor 24 and light sensor 25, the motion posture is changed from B to C to B to C to B, the heart eyes are made to flash on the display 20, and monologues ①-③ are generated from the speaker 26.

(9) When there are repeated inputs from the sound sensor 24, detection switch 59, and light sensor 25, the motion posture is changed from B to C to B to C to B, the heart eyes are made to flash on the display 20, and a laughing sound and melody are generated from the speaker 26.

(10) When there are repeated inputs from the detection switch 59 and the light sensor 25, the motion posture is changed from B to C to B to C to B, the heart eyes are made to flash on the display 20k, and a joyful outcry and melody are generated from the speaker 26.

(11) When there are inputs from the sound sensor 24 and the detection switch 59, the motion posture is changed from B to A, the round eyes are made to flash on the display 20, and a monologue ② is generated from the speaker 26.

(12) When there are inputs from the light sensor 25 and detection witch 59, the motion posture is changed from B.to C to B to C to B, the heart eyes are made to flash on the display 20, and a joyful outcry and melody are generated from the speaker 26.

As the character of this electronic toy 10 switches between the happy mode and grumpy mode in prescribed cycles based on the characteristic changes pursuant to the communication biorhythm, it is difficult for the user to predict the response of the toy to his/her input, and the user will thereby not lose interest in the toy.

It is also possible to change the cycle of the happy mode and/or the grumpy mode in accordance with the number of detections of the respective sensors. Thus, the cycle of the happy mode may be extended or the cycle of the grumpy mode may be extended pursuant to the way the user contacts the electronic toy 10. It will therefore be difficult for the user to predict the motion pattern at such time and will increase the amusement by the toy conducting unexpected actions.

The control processing of the initialization mode executed by the CPU 80 of the controller 62 is now explained.

FIG. 20 is a flowchart for explaining the initialization processing. As shown in FIG. 22, the CPU 80 of the controller 62 checks at S20 whether or not new batteries 58 have been installed. When the batteries 58 are initially installed in the battery housing 60 or when the batteries are replaced, the CPU 80 proceeds to S20, and resets the initialization value stored in the memory (not shown). Next, the initialization mode is set at S22. During this initialization mode, the electronic toy 10 has a character of a puppy, and is relatively good-tempered.

At the next S23, checked is whether or not there was input by a switch. Here, the CPU 80 monitors the detection motion of the sound sensor 24 and detection switch 59 as the detection means. When detection signals are output from the detection switch 59, the routine proceeds to S24, integrates the detection frequency n thereof, and stores such integrated value (count value + 1) in the memory. At the subsequent S24, checked is whether

prescribed time T (e.g., T=1 hour) has elapsed or not. Therefore, until 1 hour elapses from the time the batteries 58 were installed, the processing steps of S23-S25 are repeated. At S25, when 1 hour elapses, the routine proceeds to S26, and the count value n_A of the sound sensor 24 and the count value n_B of the detection switch 59 are compared.

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